

Propulsion Advisory Tool (PAT)

Thor Design Panel 3

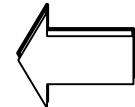
October 30, 1997
Version 1.2

1. Propulsion Advisory Tool

1.1 Propulsion Advisory Tool Introduction

1.1.1 Propulsion Advisory Tool Overview

The Propulsion Advisory Tool is an existing CCMS advisory systems application and is being re-hosted into CLCS. PAT's main function is to warn of events that could lead to LO2 geyser. In addition, the knowledge base provides intelligent sensor monitoring, real-time LO2 saturation conditions, real-time LO2 bleed flow calculations, instrumentation pre-processor health status of all black boxes with good/bad data tag for each measurements, real-time MPS/SSME helium mass calculation, Orbiter MPS helium system model, and electrical schematic model for MPS valves.



1.1.2 Propulsion Advisory Tool Description

The Propulsion Advisory Tool (PAT/G2) resides on the SDC Advanced Application Server. To access PAT, a web browser is started on a CLCS Workstation. The browser is navigated to PAT URL and the PAT button is clicked. The web server sends a PC-Xware script to the CLCS Workstation. The web browser on the CLCS Workstation launches PC-Xware and runs the script. The script opens a connection to the SDC Advanced Application Server. The user is prompted for a password for SDC Advanced Application Server. Once the password is accepted, PAT is started on the Advanced Application Server and displayed on the CLCS Workstation (via xhost). The first screen displayed on the CLCS Workstation is a matrix showing available vehicles and historical data. The user selects which data source PAT will monitor and then the PAT main screen appears.

1.2 Propulsion Advisory Tool Specifications

1.2.1 Propulsion Advisory Tool Groundrules

- PAT will run on the SDC Advanced Application Server.
- PAT will NOT run on the Command & Control Workstations.
- PAT print capability will be dependent on available and supported network printers.
- PAT will not have any on-line help. A hard copy user guide will be available.
- PAT will have access to real time data services.
- Data services must send data to PAT/GSI within 250 milliseconds upon request.
- Data services must supply data health information.

1.2.2 Propulsion Advisory Tool Functional Requirements

Functional Requirements for Propulsion Advisory Tool are arranged in the following major/minor functions:

1. Supported Tool Sets
2. Supported Environments
3. Support Data Interfaces
4. Main Display
5. Sub Displays
6. General Display Requirements
7. Knowledge Base Rules
8. Calculations
9. Sensors

1 Supported Tool Sets

- 1.1. PAT shall be developed using Gensym's G2 expert system shell.
- 1.2. PAT shall be hosted to CLCS Workstation using NCD PC-Xware.
- 1.3. The data source selection matrix shall be developed using in Java.

2 Supported Environments

- 1.1. The PAT shall be capable of being invoked from a web browser on a CLCS Support Workstation.

3 Supported Data Interfaces

- 1.1. The PAT shall use SDS CCMS real time data.
- 1.2. The PAT shall use SDC CCMS historical data.
- 1.3. The PAT shall issue a warning message if data does not arrive with the allotted amount of time.
- 1.4. The PAT shall issue a warning message if it does not process data with the allotted amount of time.

Data Analysis and Presentation Data Sources (Support for Thor)

	CDS CCMS Historical	SDC CCMS Historical	SDC CLCS Historical	SDS CCMS Real-time	SDSí CCMS et al Real- time	SCAN Server CCMS Real-time	SDS CLCS Real-time
Real Time				✓			
Historical		✓					

4 Main Display

- 1.1 Main screen display shall have the following menu options: Gensym icon, Notices, Displays, Plots, Rules, Definitions, and Other.
- 1.2 Gensym icon shall display menu selection for “User Mode”
- 1.3 The Notices menu option shall display the Notices work space.
- 1.4 The Displays menu shall contain the following: Status Window, LOX Loading, Waterfall, Predictive Model, System Status, MPS He2 Schematic, and LO2 Saturation Relationships.
- 1.5 The Plots menu option shall display the Plots work space.
- 1.6 The Rules menu shall contain the following: Initial Conditions, Phase Control, Bleed Configuration, VLV Positions, TSM Engineer Bleed, PBD Temperature, System Status, Helium Mass Calculations, Predictive Model Rules, ET Level Rules and Procs, LO2 Bleed Flow Calculations, MPS Consumables, LO2 Saturation Relationships Rules, Fault Hypothesis Rules, ECO Sensors, LOX Quality, Waterfall Rules and Procedures, Animation Rules, Instrumentation, Sensor Deviations.
- 1.7 The Definitions menu shall contain the following: Schmatic Objects, Connection Definitions, PAT Objects, PAT Sensors, PAT Variables, PAT Var-Par Definitions, GSI Interface Objects, Utility Icon Definitions, GMT Functions, G2 Speed Meter, IPP Rules and Variables, Weather Chart Definitions, Image Definitions, Menu Setup, Notices Definitions, Bulletin Board
- 1.8 The Other menu shall contain the following: Bulletin Board and G2 Speed Meter.
 - a.

5 Sub Displays

- 1.1 Propellant valves (and their associated solenoids) shall be displayed on an end-to-end electrical schematic: PD1 (LV46, LV47), PD2 (LV48, LV49), PD3 (LV50, LV51), PV1 (LV12, LV13, LV80, LV83), PV2 (LV14, LV15, LV81, LV84), PV3 (LV16, LV17, LV82, LV85), PV4 (LV18, LV19), PV5 (LV20, LV21), PV6 (LV22, LV23), PV7 (LV24), PV8 (LV25), PV9 (LV28, LV29), PV10 (LV30, LV31), PV11 (LV32, LV33), PV12 (LV34, LV35), PV13 (LV39), PV14 (LV36), PV15 (LV36), PV16 (LV36) , PV17 (LV72), PV18 (LV73), PV19 (LV76), PV20 (LV77), PV21 (LV78), PV22 (LV70), AND LV65, LV66, LV67, LV68 (17" disconnect latch solenoids).
- 1.2 Remaining MPS helium solenoid valves (and their associated solenoids) shall be displayed on an end-to-end electrical schematic: LV1, LV2, LV3, LV4, LV5, LV6, LV7, LV8, LV9, LV10, LV59, LV60, LV61, LV62, LV63, LV64, LV26, LV40, LV41, LV42, LV43, LV74, LV75.
- 1.3 Oxygen system saturation conditions shall include the following components:
 - 1.3.1 Engine #1 oxygen saturation conditions
 - 1.3.2 Engine #2 oxygen saturation conditions
 - 1.3.3 Engine #3 oxygen saturation conditions
 - 1.3.4 17" Disconnect oxygen saturation conditions
 - 1.3.5 Orbiter Inlet oxygen saturation conditions
 - 1.3.6 Plot displaying the current saturation conditions (described in sections 1.11.1 thru 1.11.5) and the theoretical saturation curve. The plot shall display pressure (pounds per square inch) on the vertical axis and temperature (degree F) on the horizontal axis.
- 1.4 Liquid oxygen (LO2) propellant loading system display shall contain PV1, PV2, PV3, PV7, PV9,PV10, PV19, PV20, PV21

- 1.5 Orbiter MPS system display shall contain the following:
 - 1.5.1 PD1
 - 1.5.2 PD1 Latch
 - 1.5.3 LO2 17 in Feed Manifold Disconnect Temperature "A"
 - 1.5.4 LO2 17 in Feed Manifold Disconnect Temperature "B"
 - 1.5.5 LO2 17 in Feed Manifold Disconnect Pressure
 - 1.5.6 LO2 Right ECO Sensor #1
 - 1.5.7 LO2 Right ECO Sensor #2
 - 1.5.8 LO2 Left ECO Sensor #3
 - 1.5.9 LO2 Left ECO Sensor #4
- 1.5.10 The facility system display shall contain the following:
 - 1.5.11 A196 Bypass Shutoff Valve
 - 1.5.12 A86461 Main Fill Valve
 - 1.5.13 A126 Pump
 - 1.5.14 A127 Pump
 - 1.5.15 Dump basin
 - 1.5.16 LO2 Storage tank
 - 1.5.17 LO2 T-0 Disconnect
 - 1.5.18 LO2 Orbiter Inlet Pressure
 - 1.5.19 LO2 Orbiter Inlet Temperature #1
 - 1.5.20 LO2 Orbiter Inlet Temperature #2
 - 1.5.21 LO2 Skid Outlet Temperature
 - 1.5.22 LO2 Skid Outlet Pressure
 - 1.5.23 LO2 TSM Engine Bleed Pressure
 - 1.5.24 LO2 TSM Engine Bleed Temperature
 - 1.5.25 MLP LO2 Drain Line Pressure
 - 1.5.26 Replenish Flow Meter
 - 1.5.27 A102416 Bypass Pressure #1
 - 1.5.28 A102416 Bypass Pressure #2
 - 1.5.29 A143 1M Pump Discharge Secondary Flow Meter
 - 1.5.30 A143 1M Pump Discharge Primary Flow Meter
 - 1.5.31 Main Fill Pump Discharge Pressure #1
 - 1.5.32 Main Fill Pump Discharge Pressure #2
 - 1.5.33 A126 Pump Speed
 - 1.5.34 A127 Pump Speed
- 1.5.35 The LO2 External Tank system display shall contain the following:
 - 1.5.36 External tank with animation to indicate tank level
 - 1.5.37 ET vent valve
 - 1.5.38 TSM Vent Valve
 - 1.5.39 A86460 Replenish Valve
 - 1.5.40 A86462 TSM Drain Valve
 - 1.5.41 SSME: An icon representing each main engine
 - 1.5.42 Engine #1 LO2 Inlet Pressure
 - 1.5.43 Engine #1 LO2 Inlet Temperature
 - 1.5.44 Engine #2 LO2 Inlet Pressure

- 1.5.45 Engine #2 LO2 Inlet Temperature
- 1.5.46 Engine #3 LO2 Inlet Pressure
- 1.5.47 Engine #3 LO2 Inlet Temperature
- 1.5.48 Engine #1 Pre-burner Pump Temperature "A"
- 1.5.49 Engine #1 Pre-burner Pump Temperature "B"
- 1.5.50 Engine #2 Pre-burner Pump Temperature "A"
- 1.5.51 Engine #2 Pre-burner Pump Temperature "B"
- 1.5.52 Engine #3 Pre-burner Pump Temperature "A"
- 1.5.53 Engine #3 Pre-burner Pump Temperature "B"
- 1.5.54 Engine #1 Anti Flood Valve Downstream Temperature "1"
- 1.5.55 Engine #1 Anti Flood Valve Downstream Temperature "2"
- 1.5.56 Engine #2 Anti Flood Valve Downstream Temperature "1"
- 1.5.57 Engine #2 Anti Flood Valve Downstream Temperature "2"
- 1.5.58 Engine #3 Anti Flood Valve Downstream Temperature "1"
- 1.5.59 Engine #3 Anti Flood Valve Downstream Temperature "2"
- 1.5.60 Engine #1 LPOT Discharge Pressure "A"
- 1.5.61 Engine #1 LPOT Discharge Pressure "B"
- 1.5.62 Engine #2 LPOT Discharge Pressure "A"
- 1.5.63 Engine #2 LPOT Discharge Pressure "B"
- 1.5.64 Engine #3 LPOT Discharge Pressure "A"
- 1.5.65 Engine #3 LPOT Discharge Pressure "B"

6 General Display Requirements

- 1.1 Each user display shall be displayed by mouse click on menu selection or mouse selection.
- 1.2 Each display shall have the capability to be hidden, shrunk, or enlarged.
- 1.3 Each displayed shall show real time data or historical data.
- 1.4 Each component line shall have the capability to display liquid flowrates through the line. In addition, the color of the line shall change based upon the condition of the oxygen within. A legend shall be included on the display to indicate conditions vs. color.
- 1.5 The MPS Helium system display shall contain all of the components within the actual system installation. Each helium line shall have the capability to change color based upon the pressure of the helium within. A legend shall be included on the display to indicate pressure vs. color. In addition, when a valve is open, it shall take on the color (ie. pressure) of the line it is attached to.
- 1.6 The Launch Commit Criteria humidity and temperature requirements shall be displayed in a graphical format. The current temperature, wind speed, and humidity measurements at the applicable Launch Pad shall also be displayed
- 1.7 The predicted pressure and temperature for the Engine #1, Engine #2, Engine #3, Orbiter Inlet, and 17" disconnect shall be displayed
- 1.8 The following system definitions workspaces shall only be accessible when G2 is in developer or administrator mode: Schematic Objects, Connection definitions, PAT Objects, PAT Sensors, Utility Icon definitions, Waterfall definitions, PAT Variables, GSI Interface Objects, GMT Functions, G2 Speed-Meter, Image Definitions, Menu Setup, Notices Definitions, Bulletin Board
 - a.

Knowledge Base Rules

- 1.1 Orbiter Valve Status: Each component in section 1.4 and 1.5 shall have corresponding rules which determine position and status. The position shall be based upon OI measurements applicable to that component's electrical circuit and fluid conditions that pertain to the position of that valve.
- 1.2 Facility Valve Position: The TSM Drain valve, TSM Vent valve, Replenish valve, Xfer line valve, Bypass Fill valve shall have corresponding rules which determine position. The position shall be based upon data applicable to that component's electrical circuit and actual fluid conditions.
- 1.3 External Tank Bubble Purge: The ET Helium Bubble Purge shall have rules which determine valve position. The position shall be based upon data applicable to that component's electrical circuit and actual fluid conditions.
- 1.4 SSME LO2 Bleed Valves: All three Engine Bleed Valves shall have rules which determine their position. The position shall be based upon OI and 60KB measurements applicable to that component's electrical circuit and fluid conditions that pertain to the position of that valve.
- 1.5 Instrumentation Pre-Processor (IPP): There shall be rules which respond to a change in preprocessor status for each measurement that is on the PAT data stream.. The user shall be notified of the change in IPP status via a change in the icon color of the measurement and a message in the notices display.
- 1.6 Propellant Loading Phase: The knowledge base shall determine and display the current phase of LO2 propellant loading based upon the data stream measurements.
- 1.7 The knowledge base shall be capable of operating in three modes: Operator, Developer, and Administrator.
- 1.8 The rectangular box shall change from grey to red when a new message is delivered to the workspace.
- 1.9 The knowledge base shall display the workspace named “STARTUP_SCREEN” when the G2 software is started.

Calculations

- 1.1 The liquid flow rate (**gallons per minute**) within any component line shall be calculated using the following formula and constants:

a. Predicted Pressure =
$$\frac{PF^2}{(448FC)^2 + EO + CO + AP}$$

b. where: PF = Predicted Flow (gpm)
c. FC = Flow Coefficient
d. EO = Elevation Offset (inches)
e. CO = Calibration Offset
f. AP = Adjacent Pressure (psia)
g.
h. Predicted Temperature =
$$\frac{PF}{TC + CO + AT}$$

- i. where: PF = Predicted Flow (gpm)
- j. TC = Temperature Coefficient
- k. CO = Calibration Offset
- l. AT = Adjacent Temperature (F)
- m. Predicted Flow = $FC \sqrt{|UP - DP|}$
- n. Where: FC = Flow Coefficient
- o. UP = Upstream pressure
- p. DP = Downstream Pressure
- q.

1.2 Helium mass (lb) shall be calculated using the following formula:

$$\text{Helium Mass} = \frac{0.3731 * P * V}{(CT)T}$$

- a. where: P = Pressure (psia)
- b. V = Volume (ft^3)
- c. $CT = \frac{-(EQ2) + \sqrt{(EQ2)^2 - 4(EQ1)(EQ3)}}{2(EQ1)}$
- d. $EQ1 = 61.849T - 9567.6$
- e. $EQ2 = 21345.1 - 78.803T$
- f. $EQ3 = 16.995 - P - 1176.6$
- g. T = Temperature (R)
- h.

1.3 The LO2 Bleed Flow rate (lb/sec) shall be calculated using the following formula:

- a. $\text{Bleed Flow Rate (lb/sec)} = \left(\frac{\sqrt{|P + 84.56 - SP|}}{0.204587} \right) \left(\frac{\sqrt{SD}}{71} \right)$
- b. Where: $SP = 704.97 - 9.1962T + 0.030468T^2$
- c. $SD = 88.397 - 0.041124T - 0.0003983T^2$
- d. P = LO2 ET Ullage Pressure #1
- e. T = Engine #1 Pre-Burner Pump Discharge Temperature "B"
- f. The bleed flow rate conversion from lb/sec to gpm is $= \frac{448.8300(\text{lb/sec})}{SD}$

9 Sensors

See appendix C for complete list of FDs.

1.2.3 Propulsion Advisory Tool Performance Requirements

1 Real Time Data

1.1 PAT/GSI must pass along data that it receives to PAT/G2 within 250 milliseconds.

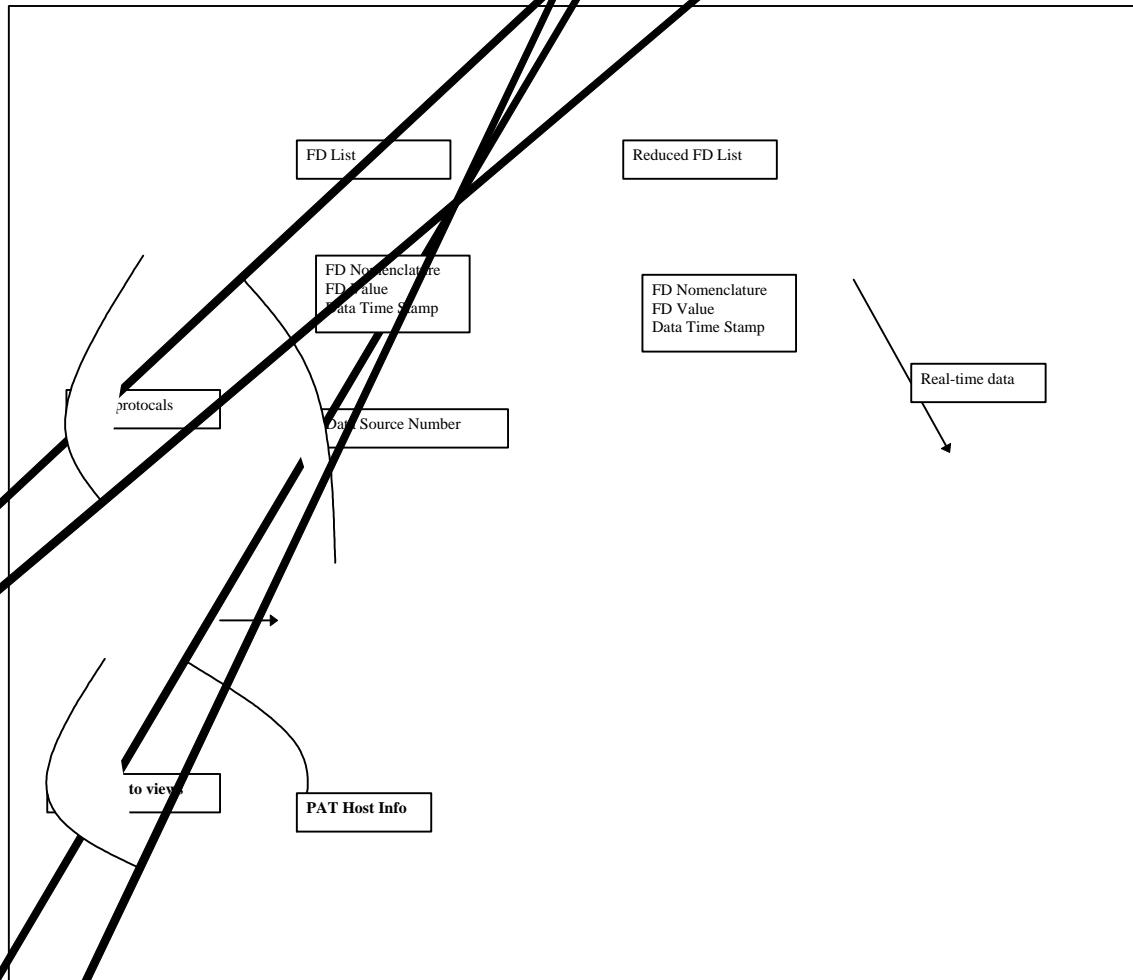
1.2 PAT/G2 must process the real-time data (0.5 seconds delay) in less than 500 milliseconds seconds.

á

1.2.4 Propulsion Advisory Tool Interfaces Data Flow Diagrams

At start up, the Propulsion Advisory Tool Graphic User Interface sends a command to the SDC Advanced Application Server. The SDC Advanced Application Server starts G2PAT and the G2 Standard Interface. Then send the G2 screen back to the users workstation. As G2 starts, it sends a list of FDs to the GSI. The GSI sends the FD list to data services for validation. Every cycle (one second) the GSI sends the current value of FDs into G2. The G2 knowledge base then accepts the data and processes.

Propulsion Advisory Tool Data Flow Diagram



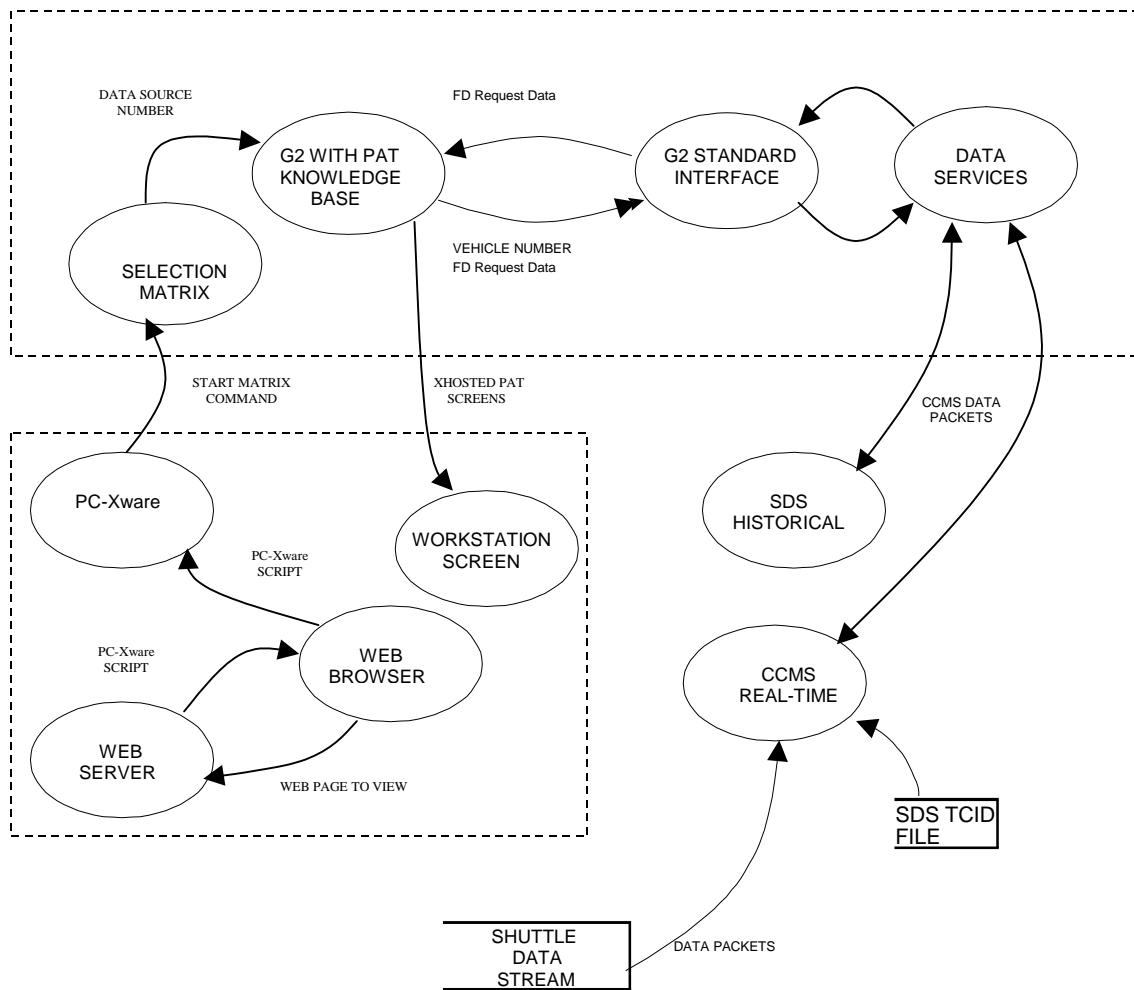
1.3 Propulsion Advisory Tool Design Specification

The Propulsion Advisory Tool's main function is to warn of events that could lead to LOX geyser. In addition, the knowledge base provides intelligent sensor monitoring, real-time LOX saturation conditions, real-time LOX bleed flow calculations, instrumentation pre-processor health status of all black boxes with good/bad data tag for each measurements, real-time MPS/SSME helium mass calculation, Orbiter MPS helium system model, and electrical schematic model for MPS valves.

1.3.1 Propulsion Advisory Tool Detailed Data Flow

The user selects a vehicle to have the Propulsion Advisory Tool (PAT) connect to by clicking the appropriate check box on the Propulsion Advisory Tool Graphic User Interface (PAT GUI). Once the user has selected a vehicle the user clicks the "Start PAT" button on the PAT GUI. This sends a command to the SDC Advanced Application Server that tests if the user-selected vehicle is available. If not, an error message is sent to the PAT GUI telling the user to select another vehicle. Otherwise PAT/G2 and the PAT G2 Standard Interface (PAT GSI) are started on the server. The PAT/G2 screen is sent to the user's workstation. PAT/G2 sends a list of FDs to the PAT GSI. The PAT GSI sends the FD list to data services for validation. Every second, the PAT GSI requests the current value for each of its FDs from the data services and sends new values to PAT/G2 for any FD that has changed.

Detailed Propulsion Advisory Tool Data Flow Diagram



1.3.2 Propulsion Advisory Tool External Interfaces

1.3.2.1 Propulsion Advisory Tool Message Formats

This data is the System Messages output by the Propulsion Advisory Tool:

1. G2/PAT Knowledge Base

Msg#	Description
1001	The [the name of V] open power C RPC is on and should be off. The valve is closed based on open RPC A off and open power indicator off.
1002	The [the name of V] open power A RPC is off and should be on. The valve is open based on close power indicator on.
1003	The [the name of V] open power C RPC is off and should be on. The valve is open based on close power indicator on.
1004	The PV-19 close power A RPC is on and should be off. The valve is open based on TSM bleed pressure, close RPC B off, close power indicator off, PV-19 closed position indicators off and the open position indicator on.
1005	The PV-19 close power B RPC is on and should be off. The valve is open based on TSM bleed pressure, close RPC A off, close power indicator off, PV-19 closed position indicators off and the open position indicator on.
1006	The PV-19 close power A and B RPC's are off and should be on. The valve is closed based on TSM bleed pressures, close RPC B on, close power indicator on, PV-19 closed position indicators on and the open position indicator off.
1007	An anomaly has been detected at the LO2 overboard bleed valve, PV-19. The valve is open based upon the TSM bleed pressure and temperature. There are two possibilities: 1-->The valve ball is fully open with the open ind. failed OFF and the closed ind. failed ON. 2--> Both the closed ind. are failed ON and the valve ball is off the open seat and leaking at a high enough flow rate to keep the downstream measurement in limits.
1008	PV-19 Problem 2C, the valve is stuck somewhere between open and closed.
1009	The LO2 overboard bleed valve (PV-19) open indication is off and should be on. The valve ball is most likely fully open with the open ind. failed OFF and both the closed ind. working correctly. Conclusion is based upon tsm bleed pressure and temperature.
1010	[the name of LS]. LO2 density in this area is [the current value of LS] which is below experience band. Check LO2 system bleed status and temperature/pressure sensors.
1011	[the name of LS]. LO2 density in this area is [the current value of LS] which is below experience band. Check LO2 system bleed status and temperature/pressure sensors.
1012	[the name of EC], [the msid of EC], is dry and should be wet for [mps-phase] phase of load.
1013	[the name of EC], [the msid of EC], is now wet and has been for the last 5 seconds.
1014	LO2 Bleed Configuration is [lo2-bleed-configuration], Loss of Bleed clock started.
1015	The MPS LO2 system is in an alternate bleed configuration with all prevalves closed. The orbiter has stable LO2 bleed flow based on PV-19, 20, 21, and E#1-3 bleed valve positions. No geyser conditions exist based on the nominal status of the LO2 manifold, orbiter inlet, and TSM bleed temperatures. However, a system drain and launch scrub is required. Approximately [et_level] of the ET has to be drained.
1016	LO2 Bleed Configuration is ascent.
1017	Instrumentation Pre-processor has detected the following data path error: [pp-status-message of S].
1018	[the name of T], [the msid of T], is above the OMRSD limit of [the omrsd-limit of T]. The trend of the measurement is [the deviation-trend-status of T].
1019	[the name of S], [the msid of S], is off scale low. The trend of the measurement is [the deviation-trend-status of S].
1020	[the name of S], [the msid of S], is off scale high. The trend of the measurement is [the deviation-trend-status of S].
1021	[the name of S], [the msid of S], is now within operational limits.

- 1022 The PBP Temperature sensors on ME-1 are not within 5 degrees, one sensor is probably bad. Temp A = [me-1_pbp_disch_temp_a] and Temp B = [me-1_pbp_disch_temp_b].
- 1023 The ME-1 PBP Temperatures are increasing this may be due to Loss of Bleed. LO2 bleed configuration is [lo2-bleed-configuration]. Loss of bleed clock has been started. Max. loss bleed time allowed is 11 minutes. Violation ref. SOOE00.122B
- 1024 The PBP Temperature sensors on me-2 are not within 5 degrees, one sensor is probably bad. Temp A = [me-2_pbp_disch_temp_a] and Temp B = [me-2_pbp_disch_temp_b].
- 1025 The me-2 PBP Temperatures are increasing this may be due to Loss of Bleed. LO2 bleed configuration is [lo2-bleed-configuration]. Loss of bleed clock has been started. Max. loss bleed time allowed is 11 minutes. Upon temperature violation ref. SOOE00.122B
- 1026 The PBP Temperature sensors on me-3 are not within 5 degrees, one sensor is probably bad. Temp A = [me-3_pbp_disch_temp_a] and Temp B = [me-3_pbp_disch_temp_b].
- 1027 The me-3 PBP Temperatures are increasing this may be due to Loss of Bleed. LO2 bleed configuration is [lo2-bleed-configuration]. Loss of bleed clock has been started. Max. loss bleed time allowed is 11 minutes. Upon temperature violation ref. SOOE00.122B.

2. PAT Data Source Selection Matrix

Msg#	Description
2001	Select vehicle to connect to, then press START.
2002	Starting G2/PAT connecting to OV-10# data source.
2003	Unable to detect OV-10# data source. Select a different vehicle and try again.

3. G2 Standard Interface

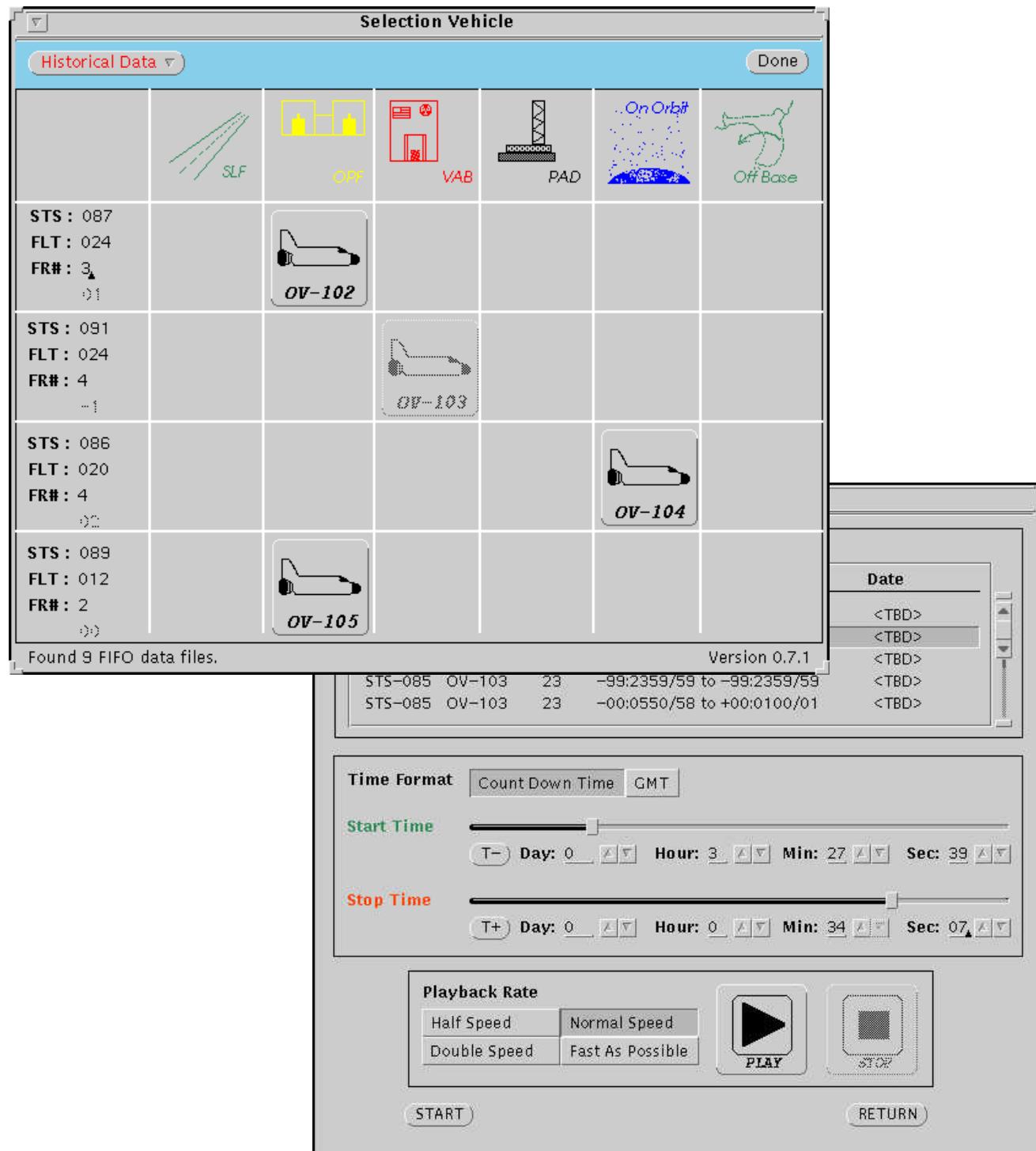
This section is not applicable to the G2 Standard Interface component.

1.3.2.2

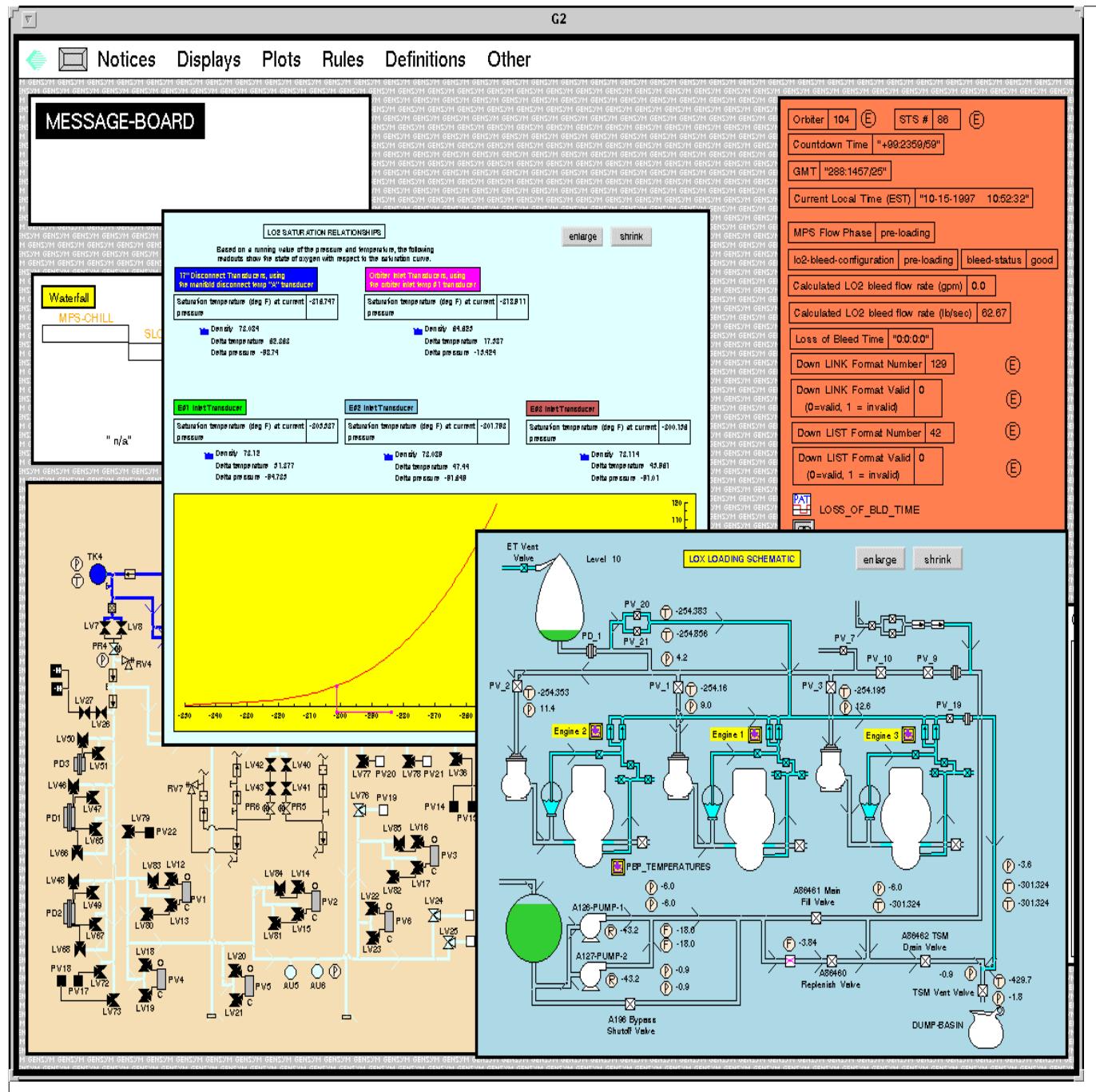
1.3.2.3 Propulsion Advisory Tool Display Formats

The following displays are a representative sample of the PAT displays. There are approximately 100 different displays in PAT. Examples of these displays are in the PAT users guide (Document 84K-____-____), along with a complete description of how they are invoked and used.

This is an example of the Data Source Selection Matrix screens:



This is a sample of the design of Displays produced by the PAT Knowledge Base.



1.3.2.3 Input Formats

This section is not applicable to the Propulsion Advisory Tool.

1.3.2.4 Recorded Data

The Propulsion Advisory Tool does not record data.

1.3.2.5 Propulsion Advisory Tool Printer Formats

The Propulsion Advisory Tool has no format reports created for the printer, users can print the screen at any time.

1.3.2.6 Interprocess Communications

- 1.1 PAT/G2 calls the remote procedure “g2_registration” within PAT/GSI when ever a sensor is first referenced. The “g2_registration” procedure receives the name of the sensor. PAT/GSI uses this information to build a FD request packet that it will send to PAT/GSI once no new sensors are registered for more than 2 seconds.
- 1.2 PAT/GSI sends a list of FD that have been requested by G2 to the data services. PAT/GSI removes and bad FDs from the list and continues to request data every second.

See appendix B. for a detail description of communication structures.

1.3.2.7 Propulsion Advisory Tool External Interface Calls (e.g., API Calling Formats)

1. Propulsion Advisory Tool API calls to Data Recording & Distribution.
2. Propulsion Advisory Tool API calls UCMS data services.

1.3.2.8 Propulsion Advisory Tool Name Table Formats

This section is not applicable to the Propulsion Advisory Tool.

1.3.3 Propulsion Advisory Tool Test Plan

The following is a diagram of the test environment:



1.1 The following hardware is needed for the Propulsion Advisory Tool Test Plan:

- A CLCS workstation (with 17” or great screen) in the Integrated Development Environment.
- A DEC Alpha workstation in the LCC named Appaloosa.
- Web Server with PC-Xware link to PAT on Appaloosa.

1.2 The following software configuration will be needed on the CLCS support workstation:

- Install a web browser (Internet Explorer 4.0 OR Netscape Navigator 4.0)
- Install NCD's PC-Xware
- Configure web browser to launch PC-Xware application.

1.3 The following software configuration will be needed on the DEC Alpha workstation (Appaloosa):

- Gensym's G2 expert system software
- The Propulsion Advisory Tool Knowledge Base
- The Propulsion Advisory Tool Knowledge G2 Standard Interface
- Data services that support Data Health
- Script to start PAT and GSI.

1.4 The following personnel are needed to perform the test:

- Quality
- CSCI Lead
- Boeing

1.5 Test Plan Objectives:

- Verify that PAT/G2 starts and is displayed to Users Workstation.
- Verify that PAT/G2 connects to the correct data source (real-time or historical).
- Verify that PAT/G2 contains all the required screens and displays.
- Verify that PAT/G2 collection of sensors receives data.
- Verify that PAT/G2 generates the correct error messages.
- Verify that PAT/G2 receives data with allotted amount of time.

APPENDIX A

	CDS CCMS Historical	SDC CCMS Historical	SDC CLCS Historical	SDS CCMS Real-time	SDS' CCMS et al Real- time	SCAN Server CCMS Real-time	SDS CLCS Real-time
RCWI	✓	✓	* FD only				
ADAT		✓	✓				
RDP		* FD only	✓				
PAT		✓	*	✓	*		*
JView		✓	*	✓	✓	✓	*
ANNT		✓	*	✓	*		*

RCWI - Robust CAP Web Interface
ADAT - Advanced Data Analysis Tool
RDP - Retrieved Data Presentation
PAT - Propulsion Advisory Tool
JView - JView (Java Version of PCGOAL)
ANNT - APU Neural Net Tool

* indicates potential future supported data source.

APPENDIX B

```
struct info{                                /* record position in file is firing room number */
    char tcid[10];
    ushort list_number;                  /** NTP Area Number                      ***/
    ushort type;                        /** ? = fifo, ? = ccp                      ***/
    ushort orbiter;                     /** Orbiter tail number                   ***/
    ushort tcid_available;             /** Is tcid file in TCID_PATH directory ***/
    ushort processed;                  /** Is NTP processing this. if 0 not processing ***/
};

struct requestSTRUCT
{
    struct srt_req_head        head;
    struct unv_MSID            parms[NPARMS];
};

struct dbrespSTRUCT                         /** net_write - verify / hand shaking */
{
    struct net_header           hdr;
    struct unv_db_desc          desc[NPARMS];
};

struct datarespSTRUCT                       /** net_write - send data*/
{
    struct unv_sampdata_hdhead;
    struct unv_samp_data        data[NPARMS];
};

struct dhrespSTRUCT
{
    struct net_header hdr;
    struct srt_data_header
    {
        char dbfil[81]; /* Database file name. */
    } data_header;
};

struct status_packet
{
    char HostName[32];                  /** Host name of Data Server ***/
    char HostIP[32];                   /** IP address of Data Server ***/
    char Type[16];                    /** CCP, FIFO, ... ***/
    char TCID[16];

    int Available;                    /** was FiringRoom; ***/
    int Area;                         /** share memory area ***/
    int OrbiterNumber;
    int STS;
    int CountDown;                    /** seconds ***/
    int GMT;                          /** seconds or is it milli-seconds ***/
    int CurrentStatus;                /** see above ***/
};
```

```
int          NetworkStatus;      /** see above **/
int          VehicleLocation; /** see above **/
};

struct statusSTRUCT
{
    struct srt_req_head      head;
    struct status_packet     status[ 25 ];
};
```

APPENDIX C

The following sensors shall be available PAT:

- D41T1715A1 - ET-LH2 98 PCT SNSR NO 1 PCT WET
- D41T1716A1 - ET-LH2 98 PCT SNSR NO 2 PCT WET
- D41T1762A1 - ET-LO2 5 PCT SENSOR PCT WET
- D41T1765A1 - ET-LO2 98 PCT SNSR NO 1 PCT WET
- D41T1766A1 - ET-LO2 98 PCT SNSR NO 2 PCT WET
- D41T1767A1 - ET-LO2 99.85 PCT SENSOR PCT WET
- D41T1768A1 - ET-LO2 100 PCT SNSR NO 1 PCT WET
- D41T1769A1 - ET-LO2 100 PCT SNSR NO 2 PCT WET
- D41T1770A1 - ET-LO2 100.15 PCT SENSOR PCT WET
- D41T1771A1 - ET-LO2 OVERFILL SENSOR PCT WET
- E41H1184D3 - ME-1 OXID BLEED VLV POSITION
- E41H2184D3 - ME-2 OXID BLEED VLV POSITION
- E41H3184D3 - ME-3 OXID BLEED VLV POSITION
- E41P1064D3 - ME-1 LPOT DISCH PRESS CH A
- E41P1065D3 - ME-1 LPOT DISCH PRESS CH B
- E41P2064D3 - ME-2 LPOT DISCH PRESS CH A
- E41P2065D3 - ME-2 LPOT DISCH PRESS CH B
- E41P3064D3 - ME-3 LPOT DISCH PRESS CH A
- E41P3065D3 - ME-3 LPOT DISCH PRESS CH B
- E41T1020D3 - ME-1 PBP DISCH TEMP CH A
- E41T1125D3 - ME-1 PBP DISCH TEMP CH B
- E41T1155A1 - ME-1 AFV DOWNSTREAM TEMP #1
- E41T1156A1 - ME-1 AFV DOWNSTREAM TEMP #2
- E41T2020D3 - ME-2 PBP DISCH TEMP CH A
- E41T2125D3 - ME-2 PBP DISCH TEMP CH B
- E41T2155A1 - ME-2 AFV DOWNSTREAM TEMP #1
- E41T2156A1 - ME-2 AFV DOWNSTREAM TEMP #2
- E41T3020D3 - ME-3 PBP DISCH TEMP CH A
- E41T3125D3 - ME-3 PBP DISCH TEMP CH B
- E41T3155A1 - ME-3 AFV DOWNSTREAM TEMP #1
- E41T3156A1 - ME-3 AFV DOWNSTREAM TEMP #2
- GECP5B17A - NORTH COIL INLET PRI PRESS IND
- GECQ8M88A - NORTH CKT COLD DSCHG R/H IND
- GECT5K91A - NORTH CLG COLD COIL TEMP IND
- GLOH2044A - A86460 REPL VLV POSITION #1
- GLOH3044A - A86460 REPL VLV POSITION #2
- GLOP0145A - A102416 BYPASS PRESS #1
- GLOP0226A - A28795 1M PUMP DISCH PRESS #1
- GLOP1146A - A102416 BYPASS PRESS #2
- GLOP1226A - A28795 1M PUMP DISCHARGE PRESS #2
- GLOP2015A - A75074 ET PREPRESS OUT PRESS #1
- GLOP2016A - A86467 SKID OUTLET PRESS
- GLOP2026A - A86470 ORBITER INLET PRESS
- GLOP2084A - A86492 MLP DRAIN LINE PRESS
- GLOP2585A - A86490 TSM ENG BLEED PRESS
- GLOP4134A - A78419 HE BUB OUTPUT PRESS
- GLOP4144A - A86927 PRI HE BUB DIFF PRESS
- GLOP4644A - A140411 SEC HE BUB DIFF PRESS
- GLOQ0229A - A143 1M PUMP DISCH FLOWRATE PRI
- GLOQ1229A - A193 1M PUMP DISCH FLOWRATE SEC
- GLOQ2009A - A86457 REPL FLOW RATE
- GLOR6304A - A126 PUMP MOTOR TACH SIGNAL

- GLOR7304A - A127 PUMP MTR TACH SIGNAL
- GLOT2017A - A86468 SKID OUTLET TEMP

- GLOT2027A - A86471 ORBITER INLET TEMP NO 1
- GLOT2588A - A86491 TSM ENG BLEED TEMP
- GLOT3027A - A147151 ORBITER INLET TEMP NO 2
- GLOX0172E - A196 BYPASS SHUTOFF VLV OPEN #1
- GLOX0173E - A196 BYPASS SHUTOFF VLV CLSD #1
- GLOX1172E - A196 BYP SHUTOFF VLV OPEN #2
- GLOX1173E - A196 BYP SHUTOFF VLV CLOSED #2
- GLOX2012E - A86461 XFER LIN FILL VLV CLSD #1
- GLOX2013E - A86461 XFER LINE FILL VLV OPEN #1
- GLOX2042E - A86460 REPL VLV CLOSED #1
- GLOX2043E - A86460 REPL VLV OPEN #1
- GLOX2112E - A86462 TSM DRAIN VLV CLSD #1
- GLOX2113E - A86462 TSM DRAIN VLV OPEN #1
- GLOX2312E - A86483 TSM VENT VLV CLSD #1
- GLOX2313E - A86483 TSM VENT VLV OPEN #1
- GLOX2703E - A105967 PREPRES ANTI-ICE PG VLV O
- GLOX3012E - A86461 XFR LIN FILL VLV CLSD #2
- GLOX3013E - A86461 XFR LIN FILL VLV OPEN #2
- GLOX3042E - A86460 REPL VLV CLOSED #2
- GLOX3043E - A86460 REPL VLV OPEN #2
- GLOX3112E - A86462 TSM DRAIN VLV CLSD #2
- GLOX3113E - A86462 TSM DRAIN VLV OPEN #2
- GLOX4143E - A78412 HE BUB PRI CNTL VLV OPEN
- GLOX4633E - A78410 HE BUB SEC SEL VLV OPEN
- GLOX4643E - A78411 HE BUB SEC CNTL VLV OPEN
- KMTLA002A - WIND SPEED CAMERA SITE 3
- KMTQA001A - AMBIENT RELATIVE HUMIDITY C SITE
- KMTTA001A - AMBIENT TEMPERATURE CAMERA SITE 3
- NLOK0401X - XFER LINE VEH CHILDDOWN COMPLETE
- NLOK0403X - ORBITER CHILDDOWN COMPLETE
- NLOK0404X - SLOW FILL COMPLETE
- NLOK0405X - FAST FILL COMPLETE
- NLOK0406X - RETURN FROM STOP FLOW
- NLOK0407X - RETURN FROM REVERT
- NLOK0408X - LOX LOAD PRELIM COMPLETE
- NLOK0503X - AUTO REPLENISH SEQ SSL0
- NLOK0506X - STOP FLOW/REVERT SSL06
- NLOK9998X - REVERT REQUEST
- NLOK9999X - STOP FLOW
- NORBTAILNO - ORBITER TAIL NUMBER
- NSTSNUMBER - STS NUMBER
- SGPCAREA1 - GPC FEP AREA 1 STATUS
- SGPCFIDA1 - GPC FEP AREA 1 FORMAT ID
- SOIADATAV - 128 OI FEP ACTIVE DATA VALID
- SOIFID - OI FEP FORMAT ID
- T41P1700C1 - ET-LH2 ULLAGE PRESS NO 1
- T41P1701C1 - ET-LH2 ULLAGE PRESS NO 2
- T41P1702C1 - ET-LH2 ULLAGE PRESS NO 3
- T41P1740H - ET/LO2 ULLAGE PRESS NO 5
- T41P1741H - ET/LO2 ULLAGE PRESS NO 6
- T41P1750C1 - ET-LO2 ULLAGE PRESSURE NO 1
- T41P1751C1 - ET-LO2 ULLAGE PRESSURE NO 2
- T41P1752C1 - ET-LO2 ULLAGE PRESSURE NO 3
- T41T1755A1 - ET-LO2 ULLAGE TEMP XT396.7
- T41X1774E1 - ET-LO2 VENT VLV NO 1 CLOSED IND
- V41P1130C1 - MPS E1 LO2 INLET PRESS

- V41P1150C1 - MPS E1 HE SUPPLY BOTTLE PRESS
- V41P1153A1 - MPS E1 REG B HE OUTLET PRESS
- V41P1154A1 - MPS E1 REG A HE OUTLET PRESS
- V41P1230C1 - MPS E2 LO2 INLET PRESS
- V41P1250C1 - MPS E2 HE SUPPLY BOTTLE PRESS
- V41P1253A1 - MPS E2 REG B HE OUTLET PRESS
- V41P1254A1 - MPS E2 REG A HE OUTLET PRESS
- V41P1330C1 - MPS E3 LO2 INLET PRESS
- V41P1350C1 - MPS E3 HE SUPPLY BOTTLE PRESS
- V41P1353A1 - MPS E3 REG B HE OUTLET PRESS
- V41P1354A1 - MPS E3 REG A HE OUTLET PRESS
- V41P1533C1 - MPS LO2 17IN FEED MANF DISC PRESS
- V41P1600A1 - MPS PNEU VLVS HE SUP BOTTLE PRESS
- V41P1605A1 - MPS PNEU VLVS REG HE OUTLET PRESS
- V41P1650A1 - MPS PNEU ACCUMULATOR PRESSURE
- V41S1119E1 - MPS E1 LH2 PREVLV (PV4) OP SW SCN
- V41S1122E1 - MPS E1 LH2 PREVLV (PV4) CL SW SCN
- V41S1155E1 - MPS E1 HE ISO VLV A(LV1) OP SW SC
- V41S1156E1 - MPS E1 HE ISO VLV B(LV2) OP SW SC
- V41S1162E1 - MPS E1 HE INTCN IN(LV59) OP SW SC
- V41S1165E1 - MPS E1 HE ISO VLV A(LV1) CL SW SC
- V41S1166E1 - MPS E1 HE ISO VLV B(LV2) CL SW SC
- V41S1168E1 - MPS E1 HE INTCN OUT(LV60)OP SW SC
- V41S1219E1 - MPS E2 LH2 PREVLV (PV5) OP SW SCN
- V41S1222E1 - MPS E2 LH2 PREVLV (PV5) CL SW SCN
- V41S1255E1 - MPS E2 HE ISO VLV A(LV3) OP SW SC
- V41S1256E1 - MPS E2 HE ISO VLV B(LV4) OP SW SC
- V41S1262E1 - MPS E2 HE INTCN IN(LV61) OP SW SC
- V41S1265E1 - MPS E2 HE ISO VLV A(LV3) CL SW SC
- V41S1266E1 - MPS E2 HE ISO VLV B(LV4) CL SW SC
- V41S1268E1 - MPS E2 HE INTCN OUT(LV62)OP SW SC
- V41S1319E1 - MPS E3 LH2 PREVLV (PV6) OP SW SCN
- V41S1322E1 - MPS E3 LH2 PREVLV (PV6) CL SW SCN
- V41S1355E1 - MPS E3 HE ISO VLV A(LV5) OP SW SC
- V41S1356E1 - MPS E3 HE ISO VLV B(LV6) OP SW SC
- V41S1362E1 - MPS E3 HE INTCN IN(LV63) OP SW SC
- V41S1365E1 - MPS E3 HE ISO VLV A(LV5) CL SW SC
- V41S1366E1 - MPS E3 HE ISO VLV B(LV6) CL SW SC
- V41S1368E1 - MPS E3 HE INTCN OUT(LV64)OP SW SC
- V41S1391E1 - MPS LH2 OTBD F/D (PV11) OP SW SCN
- V41S1393E1 - MPS LH2 OTBD F/D (PV11) CL SW SCN
- V41S1401E1 - MPS LH2 INBD F/D (PV12) OP SW SCN
- V41S1412E1 - MPS LH2 INBD F/D (PV12) CL SW SCN
- V41S1431E1 - MPS LH2 MANF REPRSS VLVS CL SW SC
- V41S1435E1 - MPS LH2 MANF REPRSS VLVS OP SW SC
- V41S1443E1 - MPS LH2 FDLN RLF SOV(PV8)OP SW SC
- V41S1443E1 - MPS LH2 FDLN RLF SOV(PV8)OP SW SC
- V41S1443E1 - MPS LH2 FDLN RLF SOV(PV8)OP SW SC
- V41S1443E1 - MPS LH2 FDLN RLF SOV(PV8)OP SW SC
- V41S1443E1 - MPS LH2 FDLN RLF SOV(PV8)OP SW SC
- V41S1443E1 - MPS LH2 FDLN RLF SOV(PV8)OP SW SC
- V41S1447E1 - MPS LH2 FDLN RLF SOV(PV8)CL SW SC
- V41S1511E1 - MPS LO2 INBD F/D (PV10) OP SW SCN
- V41S1512E1 - MPS LO2 INBD F/D (PV10) CL SW SCN
- V41S1515E1 - MPS LO2 OTBD F/D (PV9) CL SW SCN

- V41S1518E1 - MPS LO2 OTBD F/D (PV9) OP SW SCN
- V41S1531E1 - MPS LO2 MANF REPRSS VLVS CL SW SC
- V41S1535E1 - MPS LO2 MANF REPRSS VLVS OP SW SC
- V41S1543E1 - MPS LO2 FDLN RLF SOV(PV7)OP SW SC
- V41S1547E1 - MPS LO2 FDLN RLF SOV(PV7)CL SW SC
- V41S1607E1 - MPS PNEU HE ISO VLVS OP SW SCN
- V41S1609E1 - MPS PNEU HE ISO VLVS CL SW SCN
- V41S1613E1 - MPS REG HE XOVR VLV(LV10)OP SW SC
- V41S1619E1 - MPS REG HE XOVR VLV(LV10)CL SW SC
- V41T1131C1 - MPS E1 LO2 INLET TEMP
- V41T1151A1 - MPS E1 AFT FUSELAGE HE SUPPLY TEM
- V41T1152A1 - MPS E1 MID FUSELAGE HE SUPPLY TEM
- V41T1231C1 - MPS E2 LO2 INLET TEMP
- V41T1251A1 - MPS E2 AFT FUSELAGE HE SUPPLY TEM
- V41T1252A1 - MPS E2 MID FUSELAGE HE SUPPLY TEM
- V41T1331C1 - MPS E3 LO2 INLET TEMP
- V41T1351A1 - MPS E3 AFT FUSELAGE HE SUPPLY TEM
- V41T1352A1 - MPS E3 MID FUSELAGE HE SUPPLY TEM
- V41T1527A1 - MPS LO2 17IN FEED MANF DISC TEMP
- V41T1528A1 - MPS LO2 17IN FEED MANF DISC TEMP
- V41T1601A1 - MPS PNEU VLVS HE SUP BOTTLE TEMP
- V41X1102E1 - MPS E1 LH2 PREVLV CL PWR (LV19)
- V41X1103E1 - MPS E1 LH2 PREVLV OP PWR (LV18)
- V41X1104X1 - MPS E1 LH2 PREVLV (PV4) OP IND A
- V41X1105E1 - MPS E1 LH2 PREVLV (PV4) CL IND
- V41X1106X1 - MPS E1 LH2 PREVLV (PV4) OP IND B
- V41X1112E1 - MPS LH2 RECIRC VLV OP PWR (LV36)
- V41X1132E1 - MPS E1 LO2 PREVLV CL PWR 1 (LV13)
- V41X1133E1 - MPS E1 LO2 PREVLV OP PWR 1 (LV12)
- V41X1134X1 - MPS E1 LO2 PREVLV (PV1) OP IND
- V41X1135E1 - MPS E1 LO2 PREVLV (PV1) CL IND
- V41X1144E1 - MPS E1 LO2 PREVLV CL PWR 2 (LV80)
- V41X1145E1 - MPS E1 LO2 PREVLV OP PWR 2 (LV83)
- V41X1158E1 - MPS E1 HE ISO VLV A (LV1) OP PWR
- V41X1159E1 - MPS E1 HE ISO VLV B (LV2) OP PWR
- V41X1164E1 - MPS E1 HE INTCN IN (LV59) OP PWR
- V41X1170E1 - MPS E1 HE INTCN OUT (LV60) OP PWR
- V41X1202E1 - MPS E2 LH2 PREVLV CL PWR (LV21)
- V41X1203E1 - MPS E2 LH2 PREVLV OP PWR (LV20)
- V41X1204X1 - MPS E2 LH2 PREVLV (PV5) OP IND A
- V41X1205E1 - MPS E2 LH2 PREVLV (PV5) CL IND
- V41X1206X1 - MPS E2 LH2 PREVLV (PV5) OP IND B
- V41X1232E1 - MPS E2 LO2 PREVLV CL PWR 1 (LV15)
- V41X1233E1 - MPS E2 LO2 PREVLV OP PWR 1 (LV14)
- V41X1234X1 - MPS E2 LO2 PREVLV (PV2) OP IND
- V41X1235E1 - MPS E2 LO2 PREVLV (PV2) CL IND
- V41X1244E1 - MPS E2 LO2 PREVLV CL PWR 2 (LV81)
- V41X1245E1 - MPS E2 LO2 PREVLV OP PWR 2 (LV84)
- V41X1258E1 - MPS E2 HE ISO VLV A (LV3) OP PWR
- V41X1259E1 - MPS E2 HE ISO VLV B (LV4) OP PWR
- V41X1264E1 - MPS E2 HE INTCN IN (LV61) OP PWR
- V41X1270E1 - MPS E2 HE INTCN OUT (LV62) OP PWR
- V41X1302E1 - MPS E3 LH2 PREVLV CL PWR (LV23)
- V41X1303E1 - MPS E3 LH2 PREVLV OP PWR (LV22)
- V41X1304X1 - MPS E3 LH2 PREVLV (PV6) OP IND A
- V41X1305E1 - MPS E3 LH2 PREVLV (PV6) CL IND

- V41X1306X1 - MPS E3 LH2 PREVLV (PV6) OP IND B
- V41X1332E1 - MPS E3 LO2 PREVLV CL PWR 1 (LV17)
- V41X1333E1 - MPS E3 LO2 PREVLV OP PWR 1 (LV16)
- V41X1334X1 - MPS E3 LO2 PREVLV (PV3) OP IND
- V41X1335E1 - MPS E3 LO2 PREVLV (PV3) CL IND
- V41X1344E1 - MPS E3 LO2 PREVLV CL PWR 2 (LV82)
- V41X1345E1 - MPS E3 LO2 PREVLV OP PWR 2 (LV85)
- V41X1358E1 - MPS E3 HE ISO VLV A (LV5) OP PWR
- V41X1359E1 - MPS E3 HE ISO VLV B (LV6) OP PWR
- V41X1364E1 - MPS E3 HE INTCN IN (LV63) OP PWR
- V41X1370E1 - MPS E3 HE INTCN OUT (LV64) OP PWR
- V41X1381E1 - MPS LH2 17IN DISC VLV CL PWR(LV49)
- V41X1382E1 - MPS LH2 17IN DISC VLV OP PWR(LV48)
- V41X1383E1 - MPS LH2 17IN DISC LOCK PWR(LV67)
- V41X1384E1 - MPS LH2 17IN DISC UNLOCK PWR(LV68)
- V41X1385E1 - MPS LH2 OTBD F/D VLV CL PWR (LV33)
- V41X1386E1 - MPS LH2 OTBD F/D VLV OP PWR (LV32)
- V41X1388E1 - MPS LH2 OTBD F/D VLV (PV11) OP IN
- V41X1389X1 - MPS LH2 OTBD F/D VLV (PV11) CL IN
- V41X1405E1 - MPS LH2 INBD F/D VLV CL PWR (LV35)
- V41X1406E1 - MPS LH2 INBD F/D VLV OP PWR (LV34)
- V41X1409E1 - MPS LH2 INBD F/D VLV (PV12) OP IN
- V41X1410X1 - MPS LH2 INBD F/D VLV (PV12) CL IN
- V41X1419E1 - MPS LH2 4IN DISC VLV (PD3) OP IND
- V41X1420E1 - MPS LH2 4IN DISC VLV (PD3) CL IND
- V41X1429X1 - MPS LH2 17IN DISC VLV(PD2)OP IND
- V41X1430X1 - MPS LH2 17IN DISC VLV(PD2)CL IND
- V41X1434X1 - MPS LH2 17IN DISC VLV(PD2)CL IND
- V41X1436E1 - MPS LH2 MANF REPRSS 1(LV42) OP PW
- V41X1438E1 - MPS LH2 MANF REPRSS 2(LV43) OP PW
- V41X1439E1 - MPS LH2 4IN DISC VLV CL PWR (LV51)
- V41X1440E1 - MPS LH2 4IN DISC VLV OP PWR (LV50)
- V41X1441E1 - MPS LH2 FDLN RLF SOV (PV8) OP IND
- V41X1442E1 - MPS LH2 FDLN RLF SOV (PV8) CL IND
- V41X1445X1 - MPS LH2 17IN DISC VLV(PD2)OP IND
- V41X1449E1 - MPS LH2 FDLN RLF SOV CL PWR (LV25)
- V41X1458E1 - MPS LH2 TOPPING VLV OP PWR (LV39)
- V41X1467E1 - MPS LH2 HI PT BL VLV OP PWR (LV79)
- V41X1505E1 - MPS LO2 INBD F/D VLV CL PWR (LV31)
- V41X1506E1 - MPS LO2 INBD F/D VLV OP PWR (LV30)
- V41X1507E1 - MPS LO2 OTBD F/D VLV CL PWR (LV29)
- V41X1508E1 - MPS LO2 OTBD F/D VLV OP PWR (LV28)
- V41X1509X1 - MPS LO2 INBD F/D VLV (PV10) CL IN
- V41X1510E1 - MPS LO2 INBD F/D VLV (PV10) OP IN
- V41X1513E1 - MPS LO2 OTBD F/D VLV (PV9) OP IND
- V41X1514X1 - MPS LO2 OTBD F/D VLV (PV9) CL IND
- V41X1529X1 - MPS LO2 17IN DISC VLV(PD1)OP IND
- V41X1530X1 - MPS LO2 17IN DISC VLV(PD1)CL IND
- V41X1534X1 - MPS LO2 17IN DISC VLV(PD1)CL IND
- V41X1538E1 - MPS LO2 MANF REPRSS 1(LV40) OP PW
- V41X1539E1 - MPS LO2 MANF REPRSS 2(LV41) OP PW
- V41X1541E1 - MPS LO2 FDLN RLF SOV (PV7) OP IND
- V41X1542E1 - MPS LO2 FDLN RLF SOV (PV7) CL IND
- V41X1545X1 - MPS LO2 17IN DISC VLV(PD1)OP IND
- V41X1549E1 - MPS LO2 FDLN RLF SOV CL PWR (LV24)
- V41X1555X1 - MPS LO2 LEFT ECO SENSOR 1

- V41X1556X1 - MPS LO2 LEFT ECO SENSOR 2
- V41X1557X1 - MPS LO2 RIGHT ECO SENSOR 2
- V41X1558X1 - MPS LO2 RIGHT ECO SENSOR 1
- V41X1580X1 - MPS LO2 OVBD B/V (PV19) CL IND A
- V41X1581X1 - MPS LO2 OVBD B/V (PV19) CL IND B
- V41X1582E1 - MPS LO2 OVBD B/V CL PWR (LV76)
- V41X1587E1 - MPS LO2 OVBD B/V (PV19) OP IND
- V41X1614E1 - MPS REG HE XOVER VLV (LV10) OP PW
- V41X1632E1 - MPS HE SPLY BLWDWN 1 (LV26) OP PW
- V41X1634E1 - MPS HE SPLY BLWDWN 2 (LV27) OP PW
- V41X1645E1 - MPS PNEU HE ISO VLV 1 (LV7) OP PW
- V41X1646E1 - MPS PNEU HE ISO VLV 2 (LV8) OP PW
- V41X1806E1 - MPS LO2 17IN DISC VLV CL PWR(LV47)
- V41X1807E1 - MPS LO2 17IN DISC VLV OP PWR(LV46)
- V41X1808E1 - MPS LO2 17IN DISC LOCK PWR(LV65)
- V41X1809E1 - MPS LO2 17IN DISC UNLOCK PWR(LV66)
- V41X1811X1 - MPS LO2 POGO RECRC 1 (PV20) OP IN
- V41X1813E1 - MPS LO2 POGO RECRC 1 CL PWR (LV77)
- V41X1818E1 - MPS LO2 POGO RECRC 1 (PV20) CL IN
- V41X1821X1 - MPS LO2 POGO RECRC 2 (PV21) OP IN
- V41X1823E1 - MPS LO2 POGO RECRC 2 CL PWR (LV78)
- V41X1828E1 - MPS LO2 POGO RECRC 2 (PV21) CL IN
- V41X1891X1 - MPS LO2 17IN(PD1)LATCH LCKED IND
- V41X1892X1 - MPS LO2 17IN(PD1)LATCH LCKED IND
- V41X1893X1 - MPS LO2 17IN(PD1)LTCH UNLCKD IND
- V41X1894X1 - MPS LO2 17IN(PD1)LTCH UNLCKD IND
- V41X1901E1 - MPS LH2 RTLS REPRSS 1(LV74) OP PW
- V41X1902E1 - MPS LH2 RTLS REPRSS 2(LV75) OP PW
- V41X1911E1 - MPS LH2 RTLS OTBD DV OP PWR (LV73)
- V41X1917E1 - MPS LH2 RTLS OTBD DV (PV18) OP IN
- V41X1919X1 - MPS LH2 RTLS OTBD DV (PV18) CL IN
- V41X1921E1 - MPS LH2 RTLS INBD DV OP PWR (LV72)
- V41X1927E1 - MPS LH2 RTLS INBD DV (PV17) OP IN
- V41X1929X1 - MPS LH2 RTLS INBD DV (PV17) CL IN
- V41X1991X1 - MPS LH2 17IN(PD2)LATCH LCKED IND
- V41X1992X1 - MPS LH2 17IN(PD2)LATCH LCKED IND
- V41X1993X1 - MPS LH2 17IN(PD2)LTCH UNLCKD IND
- V41X1994X1 - MPS LH2 17IN(PD2)LTCH UNLCKD IND
- V76X0501E1 - MPS-LH2 RELIEF SOV RPC A ON
- V76X0501E1 - MPS-LH2 RELIEF SOV RPC A ON
- V76X0503E1 - MPS-LH2 RELIEF SOV RPC C ON
- V76X0503E1 - MPS-LH2 RELIEF SOV RPC C ON
- V76X4010E1 - PCA-MPS LO2 PREVLV 1-2 CL RPC A O
- V76X4011E1 - PCA-MPS LO2 PREVLV 1-2 CL RPC B O
- V76X4013E1 - PCA-MPS LO2 PREVLV 2-2 CL RPC B O
- V76X4014E1 - PCA-MPS LO2 PREVLV 2-2 CL RPC C O
- V76X4016E1 - PCA-MPS LO2 PREVLV 3-2 CL RPC A O
- V76X4017E1 - PCA-MPS LO2 PREVLV 3-2 CL RPC C O
- V76X4040E1 - PCA-MPS LO2 PREVLV 1-2 OP RPC A O
- V76X4041E1 - PCA-MPS LO2 PREVLV 1-2 OP RPC B O
- V76X4041E1 - PCA-MPS LO2 PREVLV 1-2 OP RPC B O
- V76X4041E1 - PCA-MPS LO2 PREVLV 1-2 OP RPC B O
- V76X4043E1 - PCA-MPS LO2 PREVLV 2-2 OP RPC B O
- V76X4047E1 - PCA-MPS LO2 PREVLV 3-2 OP RPC C O
- V76X4110E1 - PCA-MPS LH2 PREVLV 1 OP RPC A ON
- V76X4111E1 - PCA-MPS LH2 PREVLV 1 OP RPC B ON

- V76X4113E1 - PCA-MPS LH2 PREVLV 1 CL RPC A ON
- V76X4114E1 - PCA-MPS LH2 PREVLV 1 CL RPC B ON
- V76X4116E1 - PCA-MPS LH2 PREVLV 2 OP RPC B ON
- V76X4117E1 - PCA-MPS LH2 PREVLV 2 OP RPC C ON
- V76X4119E1 - PCA-MPS LH2 PREVLV 2 CL RPC B ON
- V76X4120E1 - PCA-MPS LH2 PREVLV 2 CL RPC C ON
- V76X4122E1 - PCA-MPS LH2 PREVLV 3 OP RPC C ON
- V76X4123E1 - PCA-MPS LH2 PREVLV 3 OP RPC A ON
- V76X4125E1 - PCA-MPS LH2 PREVLV 3 CL RPC C ON
- V76X4126E1 - PCA-MPS LH2 PREVLV 3 CL RPC A ON
- V76X4130E1 - PCA-MPS LOX PREVLV 1 OP RPC A ON
- V76X4131E1 - PCA-MPS LOX PREVLV 1 OP RPC B ON
- V76X4133E1 - PCA-MPS LOX PREVLV 1 CL RPC A ON
- V76X4134E1 - PCA-MPS LOX PREVLV 1 CL RPC B ON
- V76X4136E1 - PCA-MPS LOX PREVLV 2 OP RPC B ON
- V76X4137E1 - PCA-MPS LOX PREVLV 2 OP RPC C ON
- V76X4139E1 - PCA-MPS LOX PREVLV 2 CL RPC B ON
- V76X4140E1 - PCA-MPS LOX PREVLV 2 CL RPC C ON
- V76X4142E1 - PCA-MPS LOX PREVLV 3 OP RPC C ON
- V76X4143E1 - PCA-MPS LOX PREVLV 3 OP RPC A ON
- V76X4145E1 - PCA-MPS LOX PREVLV 3 CL RPC C ON
- V76X4146E1 - PCA-MPS LOX PREVLV 3 CL RPC A ON
- V76X4151E1 - PCA MPS E1 HE INTCN IN/OP RPC A O
- V76X4152E1 - PCA MPS E1 HE INTCN IN/OP RPC B O
- V76X4155E1 - PCA MPS E2 HE INTCN IN/OP RPC B O
- V76X4156E1 - PCA MPS E2 HE INTCN IN/OP RPC C O
- V76X4158E1 - PCA MPS E3 HE INTCN IN/OP RPC C O
- V76X4159E1 - PCA MPS E3 HE INTCN IN/OP RPC A O
- V76X4161E1 - PCA MPS INBD RTLS DUMP RPC A ON
- V76X4162E1 - PCA MPS OTBD RTLS DUMP RPC A ON
- V76X4163E1 - PCA MPS INBD RTLS DUMP RPC C ON
- V76X4164E1 - PCA MPS OTBD RTLS DUMP RPC C ON
- V76X4165E1 - PCA MPS RTLS REPRESS 1 RPC A ON
- V76X4166E1 - PCA MPS RTLS REPRESS 1 RPC C ON
- V76X4167E1 - PCA MPS RTLS REPRESS 2 RPC A ON
- V76X4168E1 - PCA MPS RTLS REPRESS 2 RPC C ON
- V76X4171E1 - PCA MPS ENG 1 HE VLV B RPC B ON
- V76X4172E1 - PCA MPS ENG 1 HE VLV B RPC C ON
- V76X4173E1 - PCA MPS ENG 2 HE VLV B RPC A ON
- V76X4174E1 - PCA MPS ENG 2 HE VLV B RPC C ON
- V76X4175E1 - PCA MPS ENG 3 HE VLV B RPC A ON
- V76X4176E1 - PCA MPS ENG 3 HE VLV B RPC B ON
- V76X4178E1 - PCA MPS POGO BLEED RPC B ON
- V76X4179E1 - PCA MPS POGO BLEED RPC C ON
- V76X4186E1 - PCA-MPS LH2 FEED D/V OP RPC B ON
- V76X4187E1 - PCA-MPS LH2 FEED D/V OP RPC C ON
- V76X4189E1 - PCA-MPS LH2 FEED D/V CL RPC B ON
- V76X4190E1 - PCA-MPS LH2 FEED D/V CL RPC C ON
- V76X4196E1 - PCA-MPS LOX FEED D/V OP RPC B ON
- V76X4197E1 - PCA-MPS LOX FEED D/V OP RPC C ON
- V76X4199E1 - PCA-MPS LOX FEED D/V CL RPC B ON
- V76X4200E1 - PCA-MPS LOX FEED D/V CL RPC C ON
- V76X4420E1 - MPS-LO2 FD DISC LOCK VLV RPC B ON
- V76X4421E1 - MPS-LO2 FD DISC LOCK VLV RPC C ON
- V76X4422E1 - MPS LO2 FD DISC UNLOCK V RPC B ON
- V76X4423E1 - MPS-LO2 FD DISC UNLOCK V RPC C ON

- V76X4430E1 - MPS-LH2 FD DISC LOCK VLV RPC B ON
- V76X4431E1 - MPS-LH2 FD DISC LOCK VLV RPC C ON
- V76X4432E1 - MPS-LH2 FD DISC UNLOCK V RPC B ON
- V76X4433E1 - MPS-LH2 FD DISC UNLOCK V RPC C ON

1.2.2.1 Propulsion Advisory Tool Future Requirements and Ideas

1.1 TBD by MPS Engineer

1.1 The PAT shall display a menu bar at the top of the knowledge base window. The menu bar shall contain the following mouse activatable items:

1.2 Notices indicator: displays “Notices” workspace

1.3 Initial Conditions: Subworkspaces containing the following:

1.4 Saturation related Initial Conditions

1.5 Sensor Attribute Related

1.6 Workspace Related

1.7 Loading Phase Related

1.8 Waterfall Related Initial Conditions

1.9 External Tank Liquid Level

1.10 Animation Rules:

1.11 Helium Bottle Animation

1.12 Junction Animation

1.13 One Way Object Animation

1.14 Valve Animation

1.15 Pressure Regulator Animation

1.16 Disconnect Animation

1.17 Valve Positions

1.18 LOX Quality

1.19 Consumables Report

1.20 IPP Status rules

1.21 Phase Control

1.22 Bleed Configuration rules

1.23 TSM Engine Bleed rules

a.

b.

1.14 Anomaly rules: Subworkspaces containing the following:

1.15 Sensor deviations

1.16 Instrumentation

1.17 PBP Temperature Rules

1.18 Helium mass Calculation

1.19 Exponential Filter

1.20 Predictive Model Rules

1.21 ET Level Rules & Procs

1.22 LO2 Bleed Flow Calculations

1.23 LO2 Saturation Relationship Rules

1.24 LO2 Saturation Chart Procedures

1.25 ECO Sensors

1.26 Weather Rules Procedures

1.27 Fault Injection Procedures